Materials Engineering Branch

TIP*

No. 067 Reduction of Torque for Lubricated Fasteners

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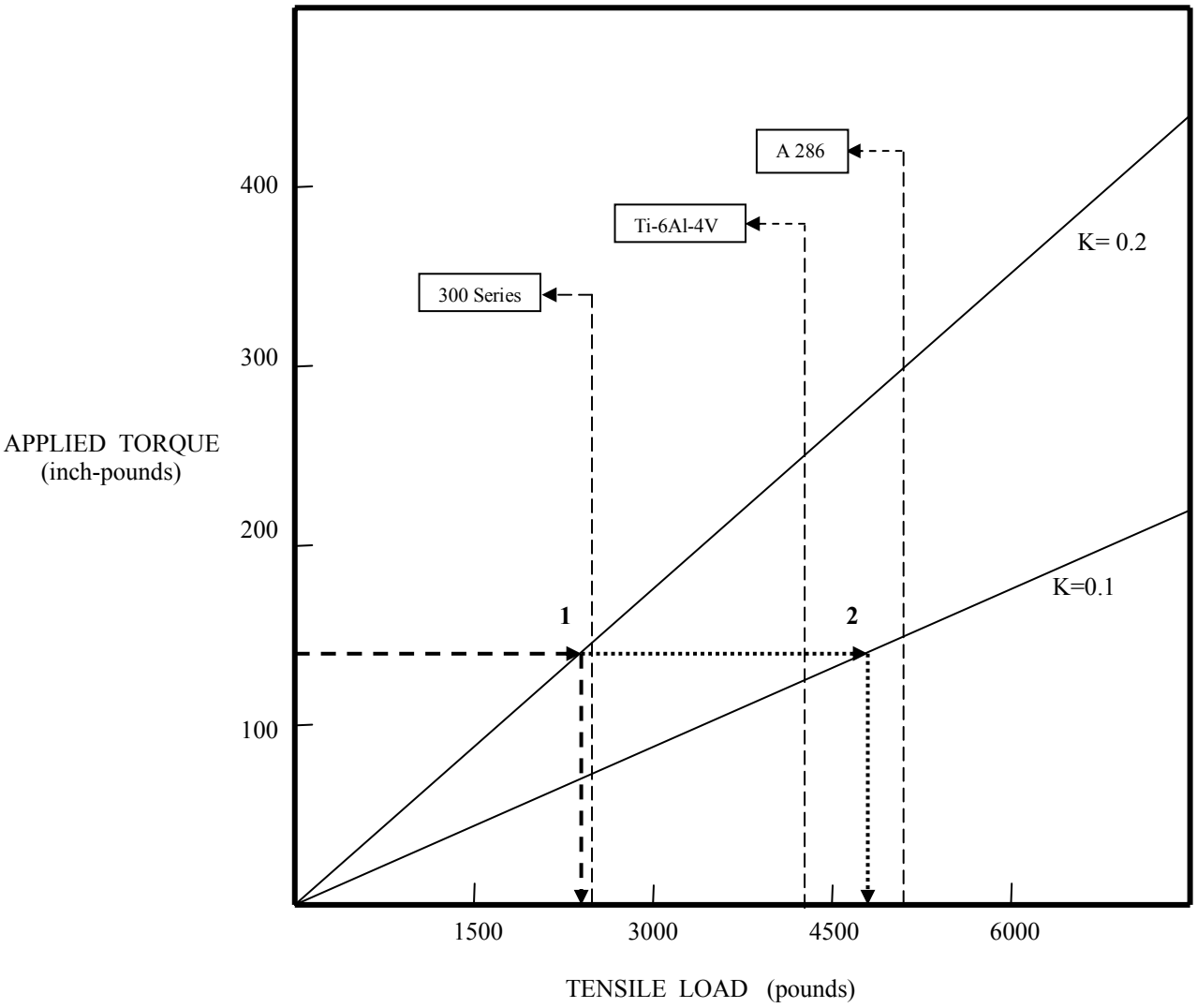
Bolt stress provides the principal resistance to the loosening of a fastener in service provided that the tensile stress does not exceed the proportional limit stress (or proof stress) for a particular bolt. Under-torqued bolts can shake loose while over-torqued fasteners can become permanently damaged or weakened.

Since frictional forces resist most of the tightening torque, the coefficient of friction should be known in selecting a proper torque for a particular set of parts. In addition, the repeated use of a fastener assembly changes these frictional forces. In practice, the tensile loads are difficult to assess unless torque-tension test equipment is used.

In an effort to prevent galling of spacecraft fasteners, a lubricant is often used. The thread and bolt head frictional coefficient can change from about 0.200 to as low as 0.100 for dry and lubricated conditions, respectively. A wide variation in the torque vs. tensile load relationship can result. To illustrate this (Figure 1), a ¼-28 bolt was selected and these values are depicted graphically. The value k, shown on the graph, is an empirical number related to the coefficient of friction. Also shown are the load limits for three common fastener materials. In practice, it is expected that the actual conditions will fall between the two lines depending upon the materials and surface conditions of the contacting parts.

The concern for a proper torque specification depends directly on how critical is the application and achieving a particular tensile load. In critical situations it would necessitate appropriate testing of the configuration to arrive at a proper torque. Without test data in non-critical applications, the normal torque should be reduced about 50% when lubrication is provided.

Figure 1. Torque vs. Load (¼ - 28 bolt)



As an example: If a ¼-28 bolt is torqued to 140 inch-pounds, a load of 2400 pounds would be expected under normal conditions (see point 1 on Fig. 1). However, if the threads are smooth, lubricated with oil beneath the washer, where the coefficient of friction has been reduced from 0.20 to 0.10, the bolt load would be 4800 pounds (see point 2 on Fig. 1). Depending on the maximum strength of the bolt material, fracture could occur. In this example the 300 Series and the Ti-6Al-4V bolts would have fractured. To avoid bolt fracture, the specified torque value should be lowered to 100 inch-pounds for the Ti-6Al-4V bolts and less than 50 inch-pounds for the 300 Series bolts.